LArTPC Reconstruction Meeting

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July 29, 2011

Introduction

- Purpose of this meeting(s): To have in-depth discussion of techniques for reconstructing events in LArTPC.
  - Try to keep focus on topics of interest to most LArTPC experiments (ArgoNeuT+MicroBooNE+LBNE+?)
  - Would like to use this first meeting to identify topics we should focus on.
  - Better coordination amongst those of us working on developing reconstruction tools would be good.
- **Not** the purpose of this meeting(s): In-depth discussions of code.
  - LArSoft meetings or collaboration-specific meetings are better venues for that.
  - We can/should discuss anything good/bad with existing implementations of code/algorithms and feed those thoughts back to LArSoft.

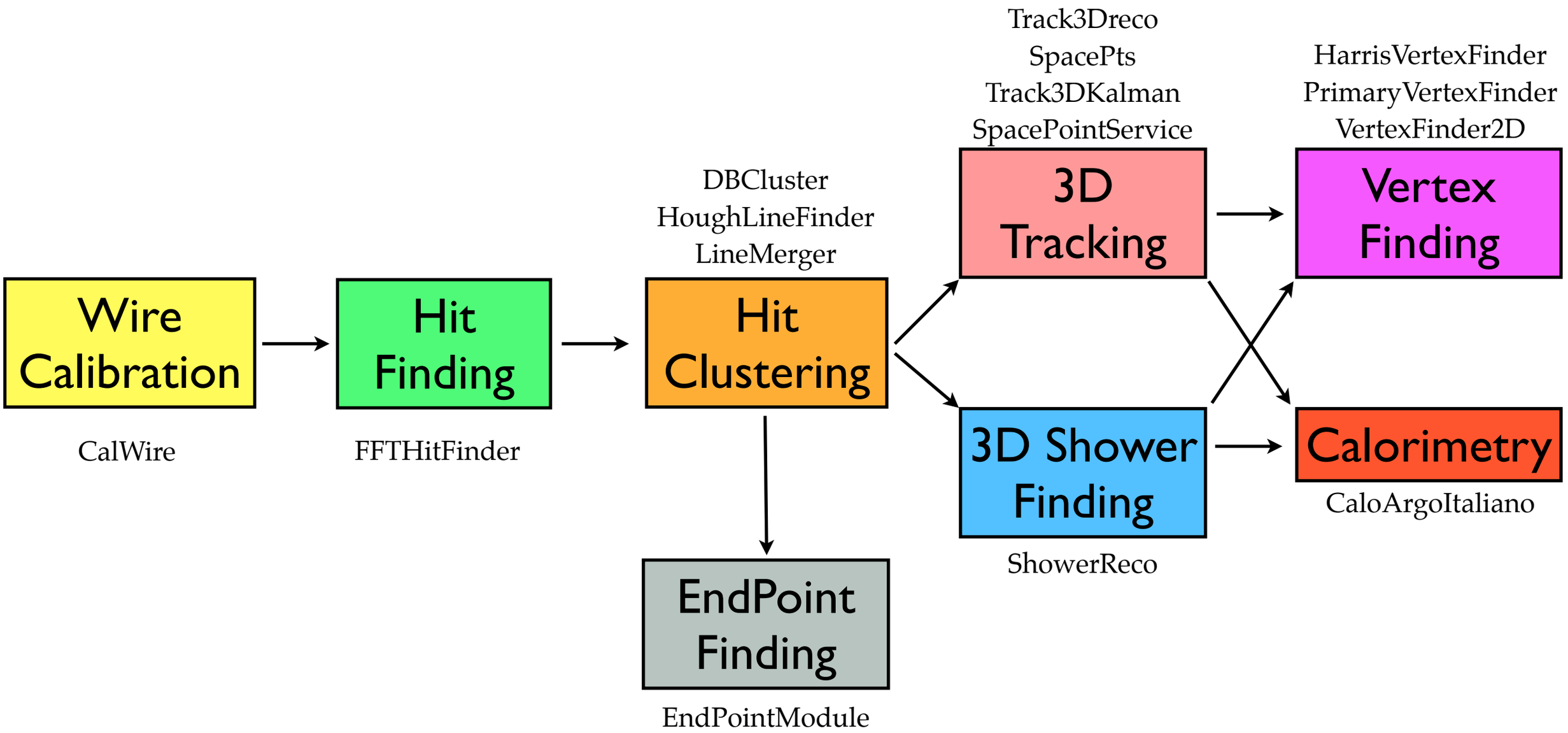
Existing Reconstruction Objects

Reconstruction Object	Purpose	Notes
Wire	Holds post-FFT signal for a channel	
Hit	A grouping of related/continuous ADC values.	
Cluster	A grouping of related Hits	
Prong (Shower/Track)	Holds a grouping of related Clusters and identified SpacePoints	Shower/Track inherit from Prong.
SpacePoint	A grouping of Hits from different views...used so far to define an XYZ point.	Does not have to be a 1-1 association between planes.
EndPoint2D	A grouping of Hits that are located a common endpoint/vertex?	I don't really understand this one.
Vertex	A grouping of related Showers/Tracks.	
Event	A grouping of related Vertices.	Meant to have some summary information for the event.

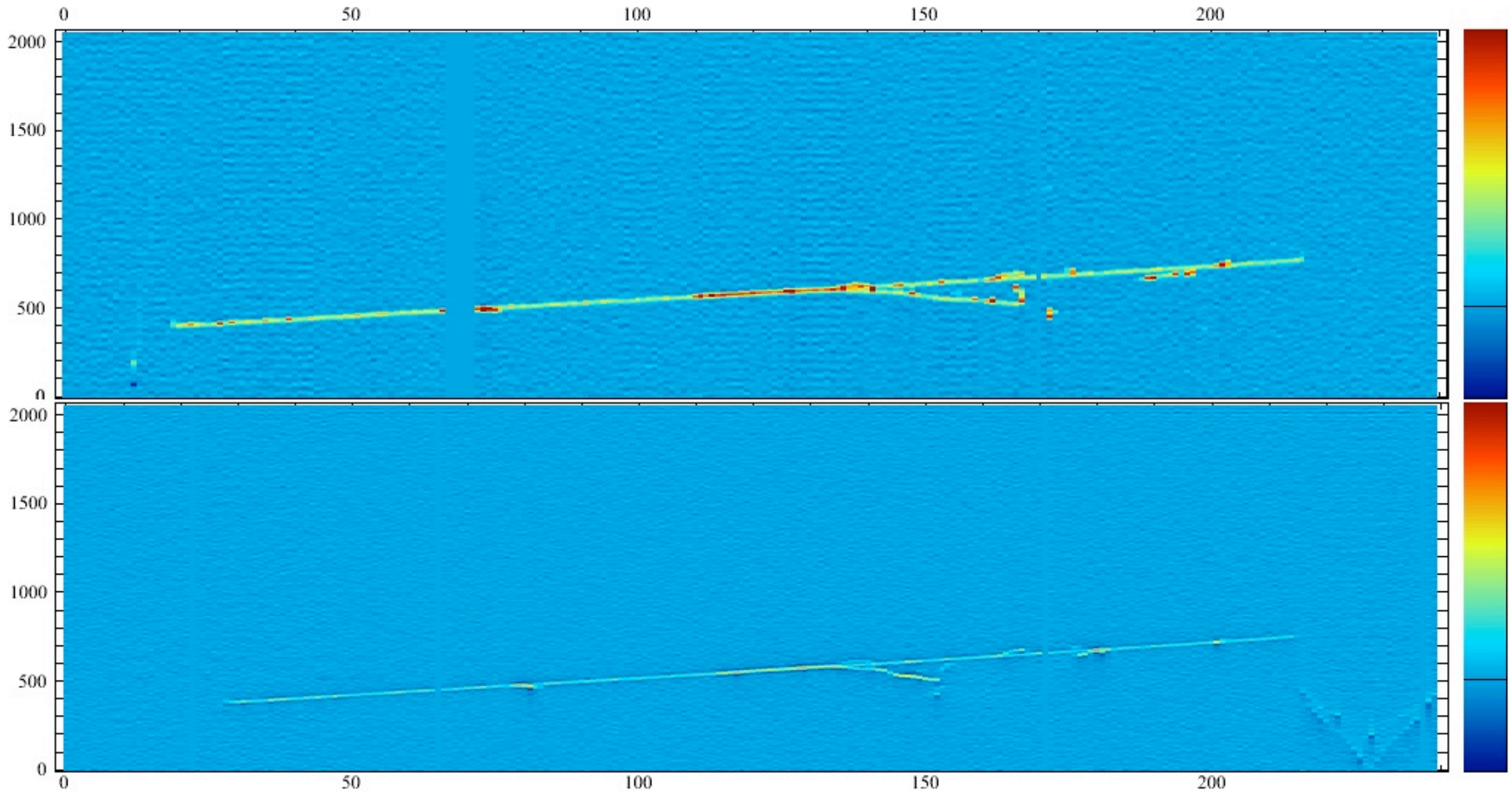
- There is no Object/Placeholder for Calorimetric information. There should be.
- I am unaware of the plan for how to store PMT/Light information for MicroBooNE/LBNE.

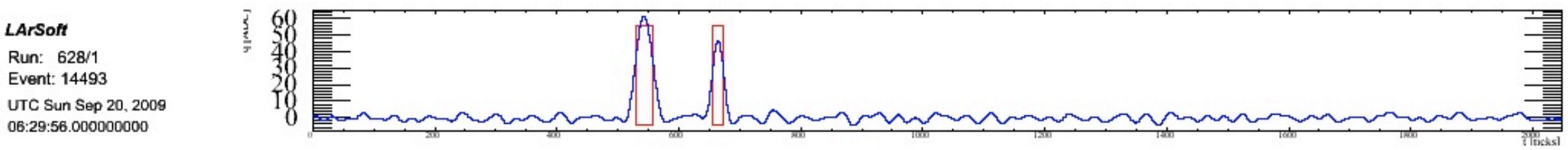
Existing Reconstruction Modules

User can choose a path through this chain using as many of the modules as they wish.

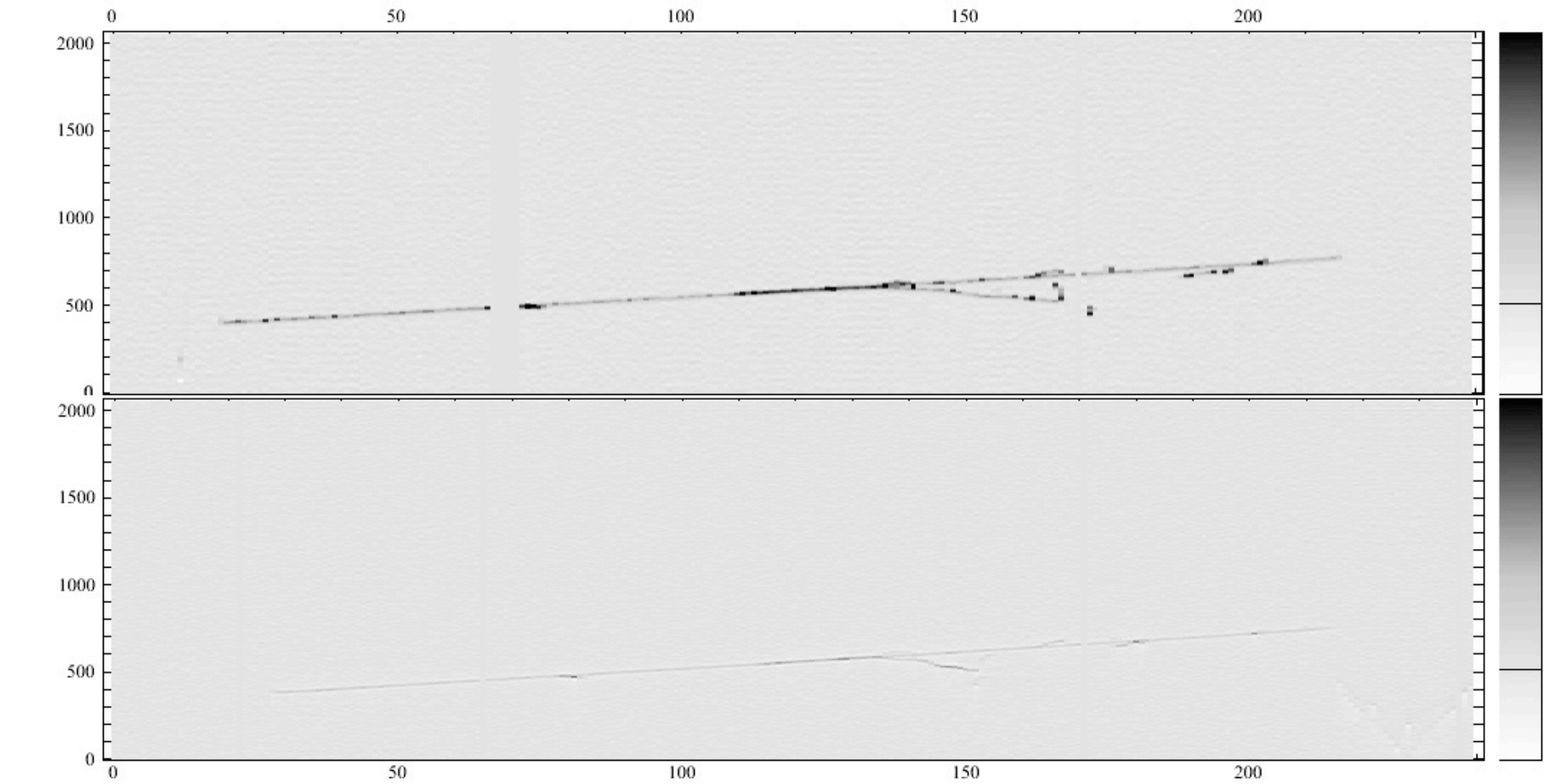


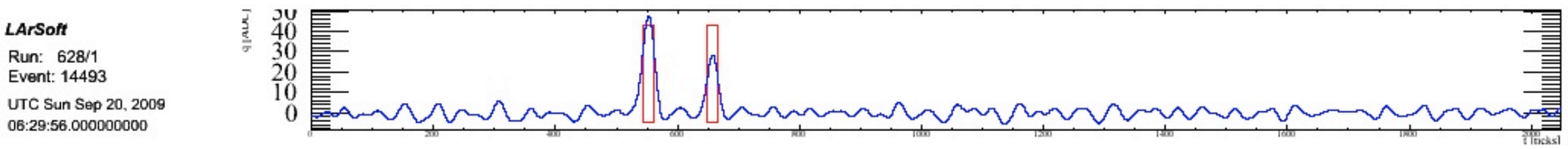
Example 1: Calibrated Data in Color



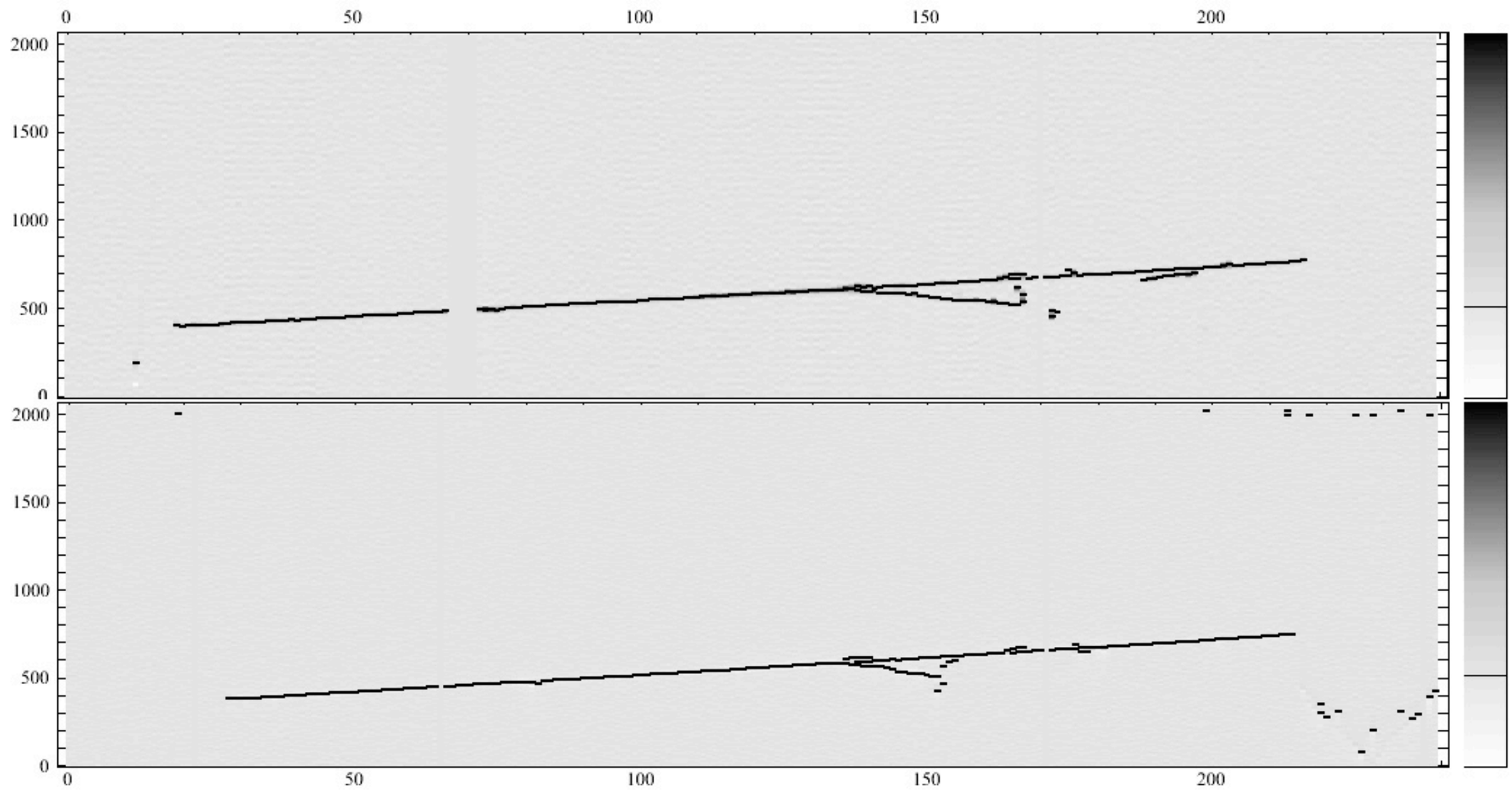


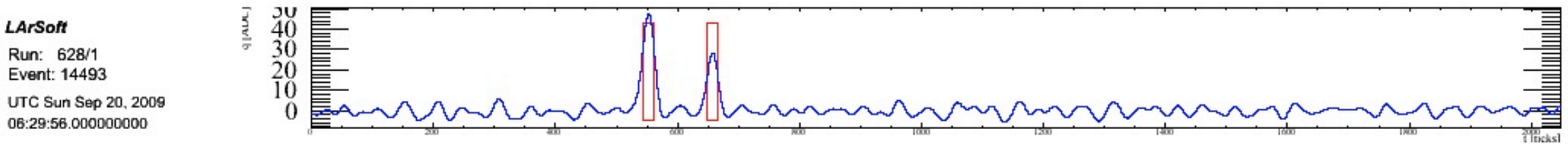
Example 1: Calibrated Data in B&W



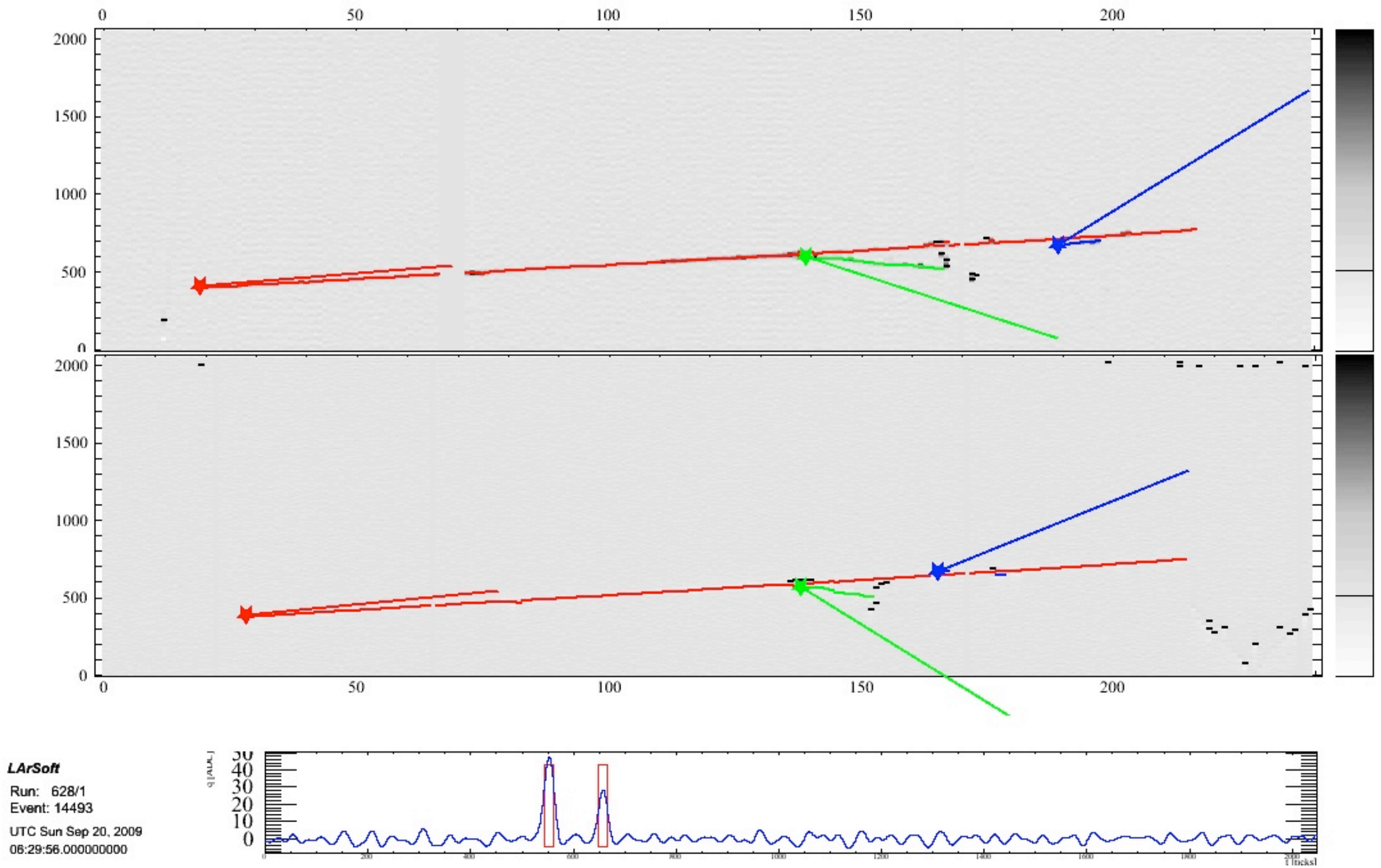


Example 1: Hits superimposed.

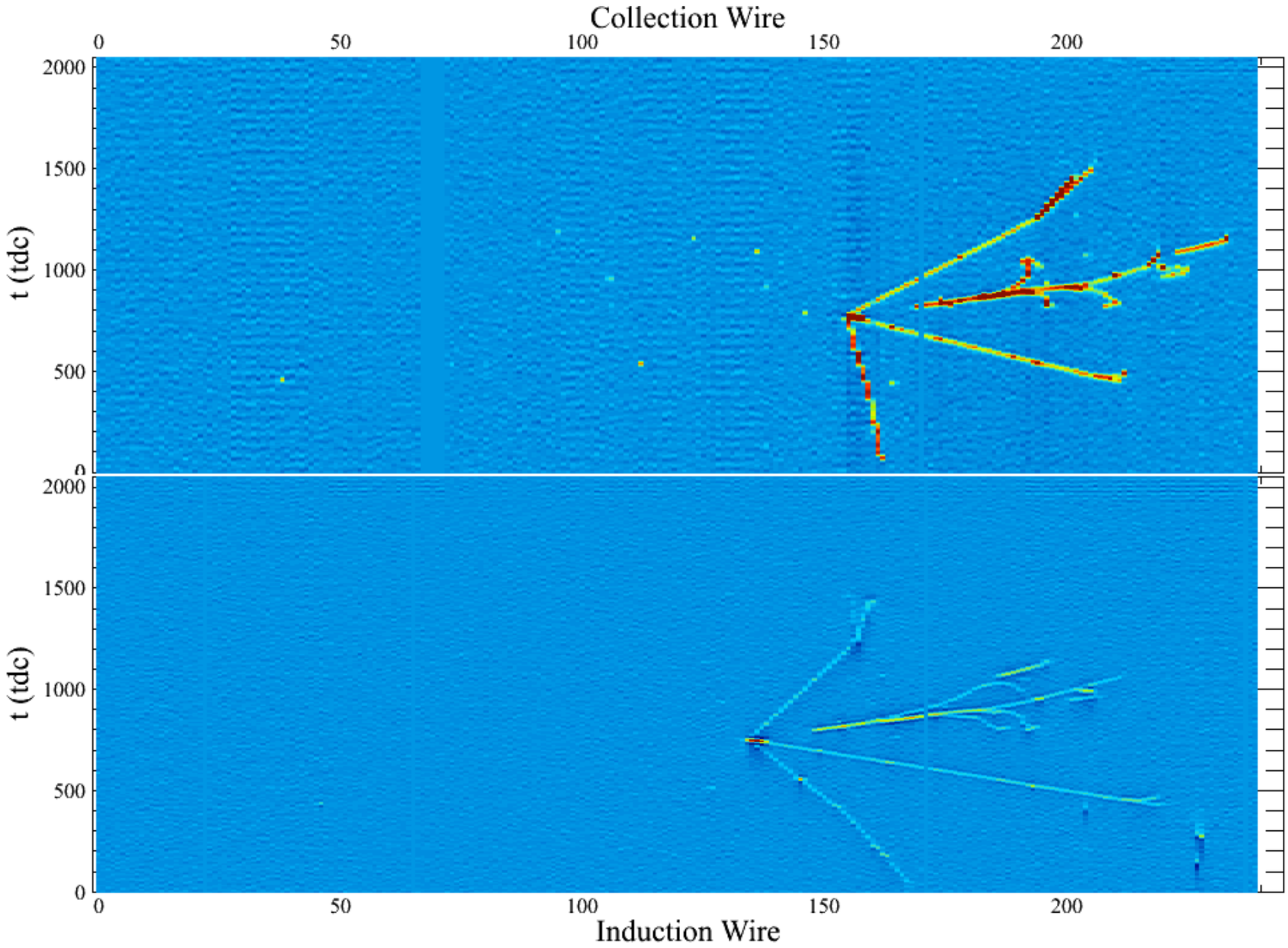




Example 1: Tracks superimposed.



Example 2: Calibrated Data in color.



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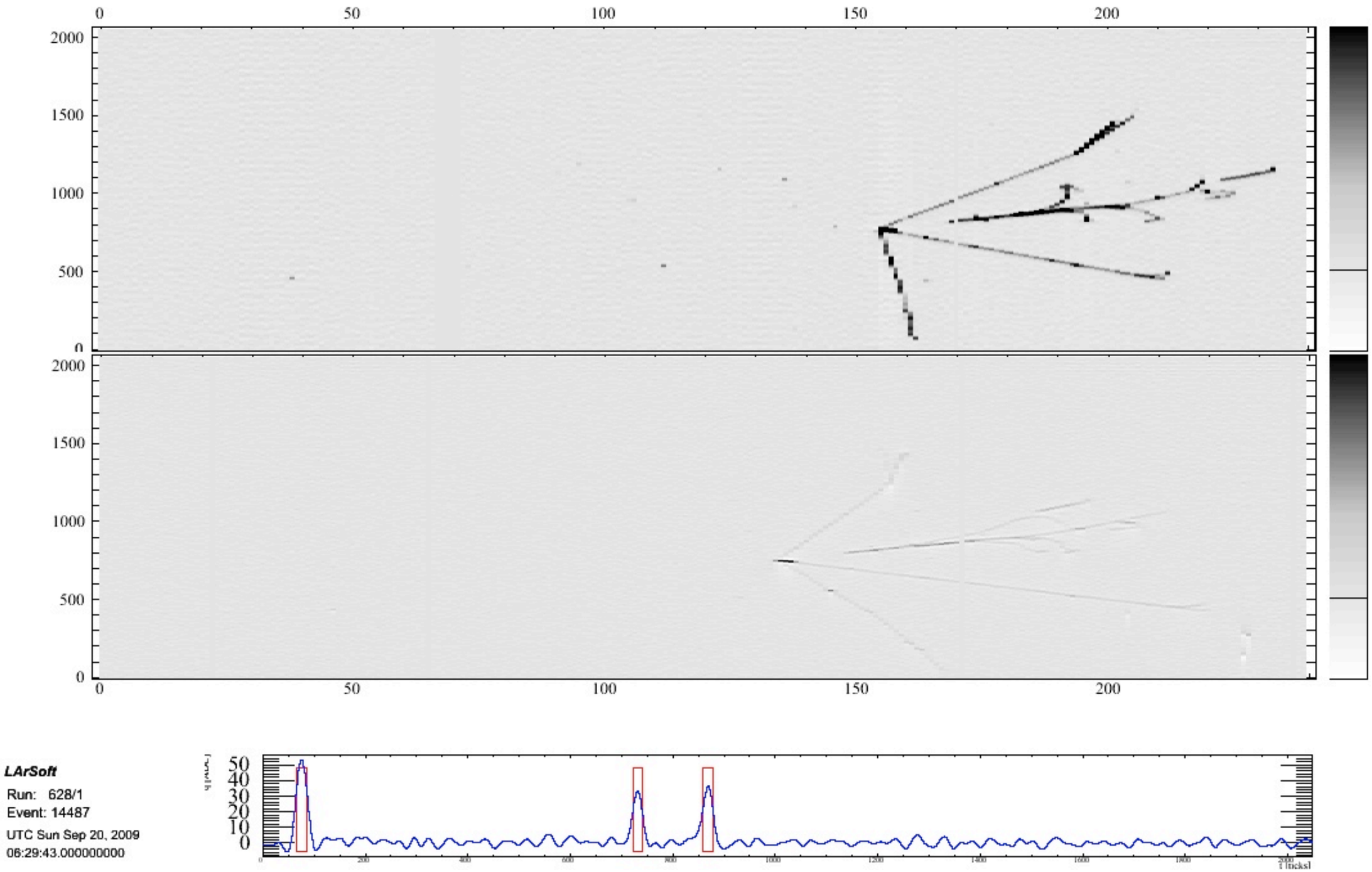

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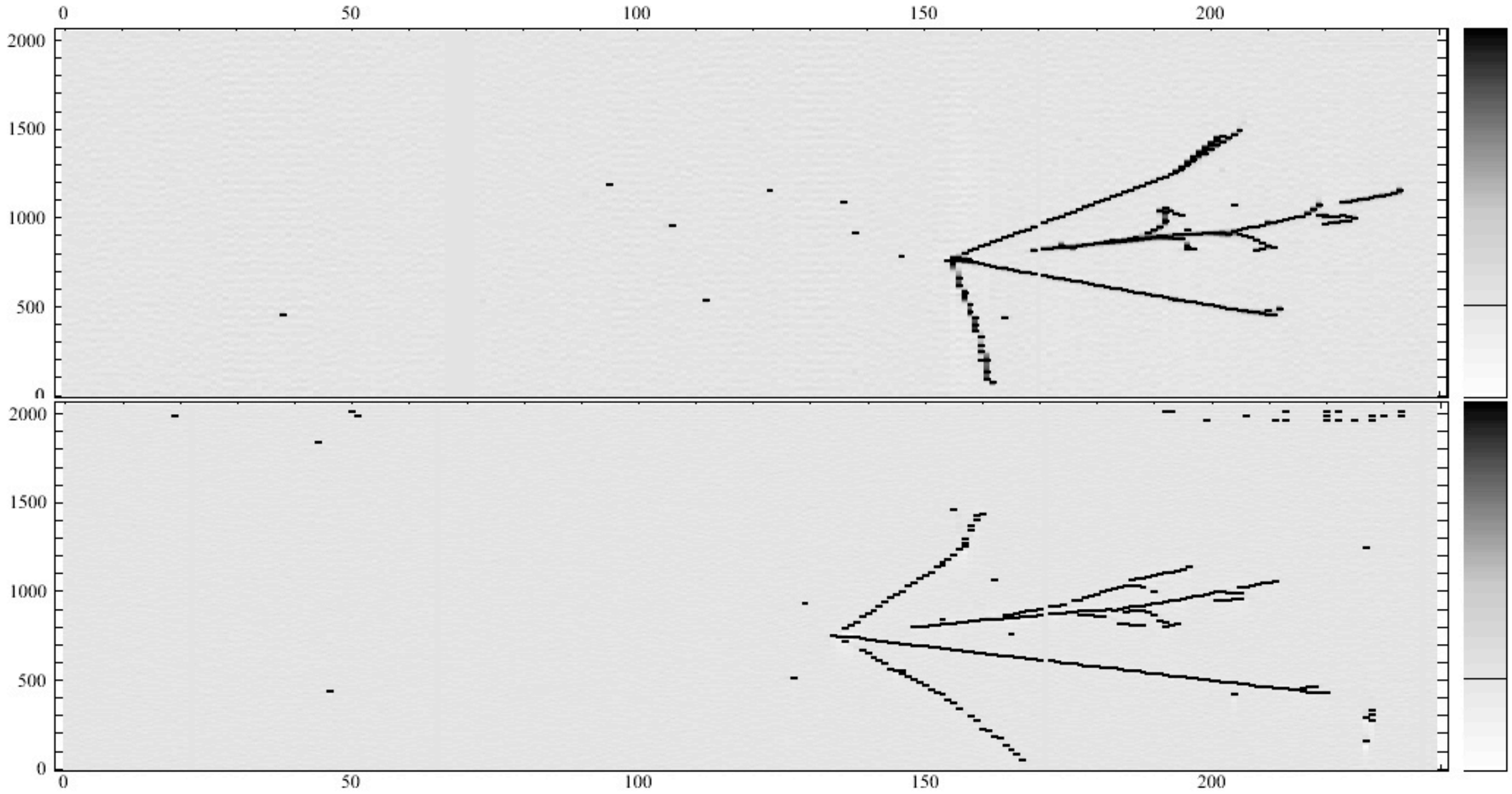

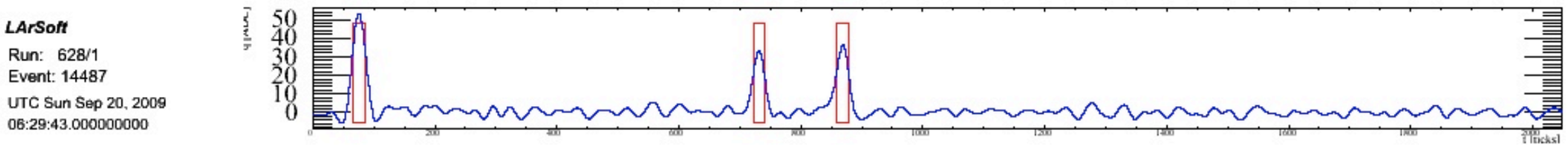

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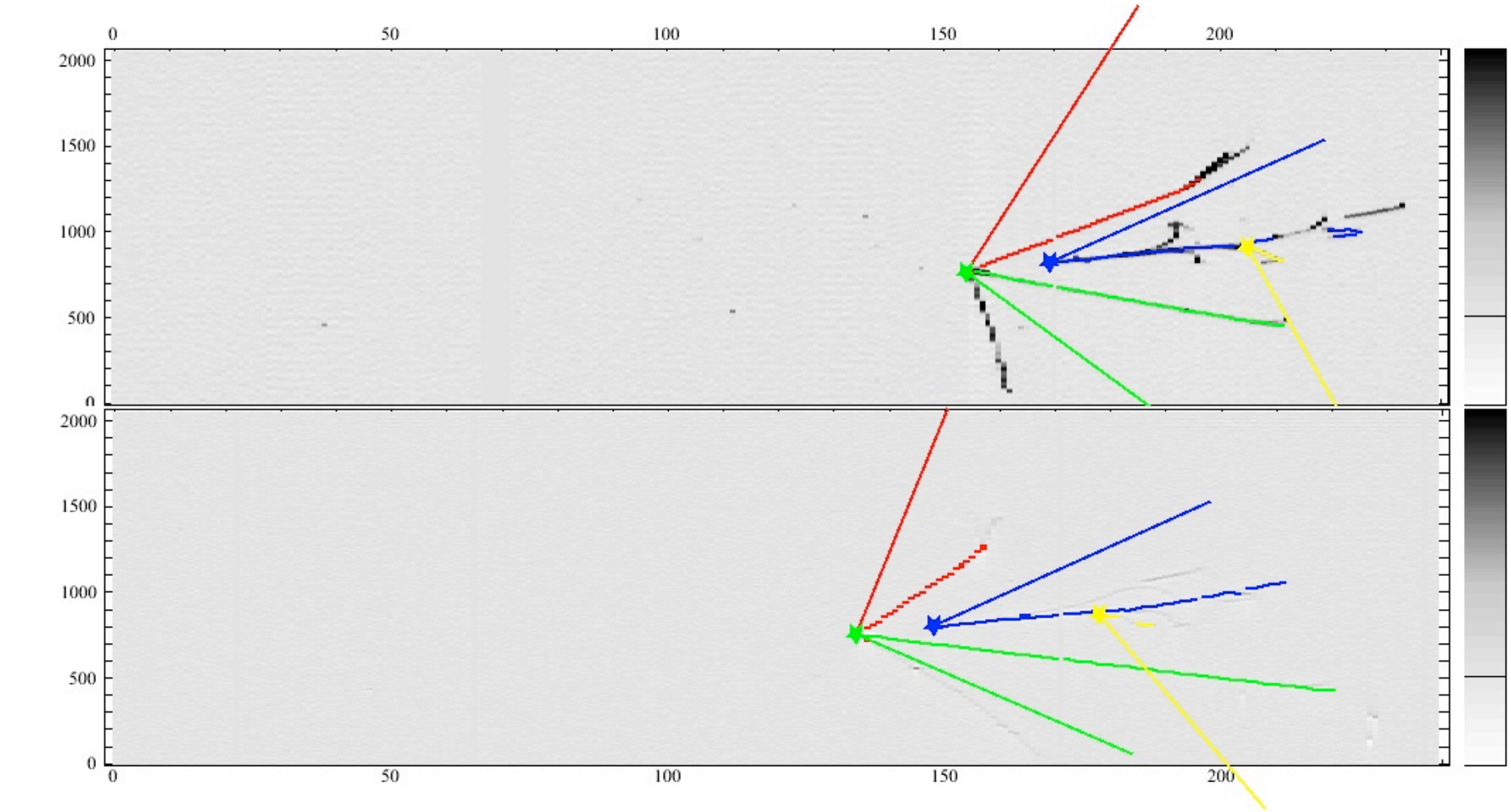
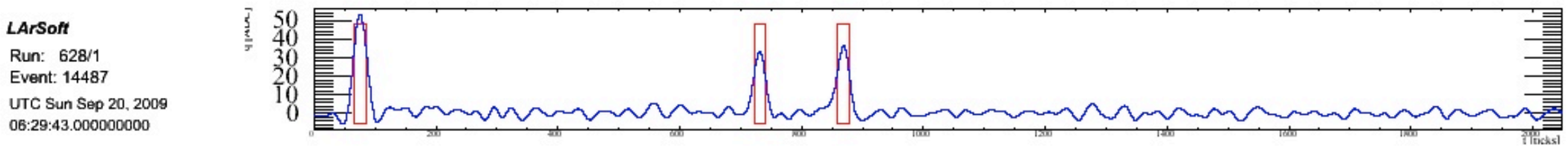
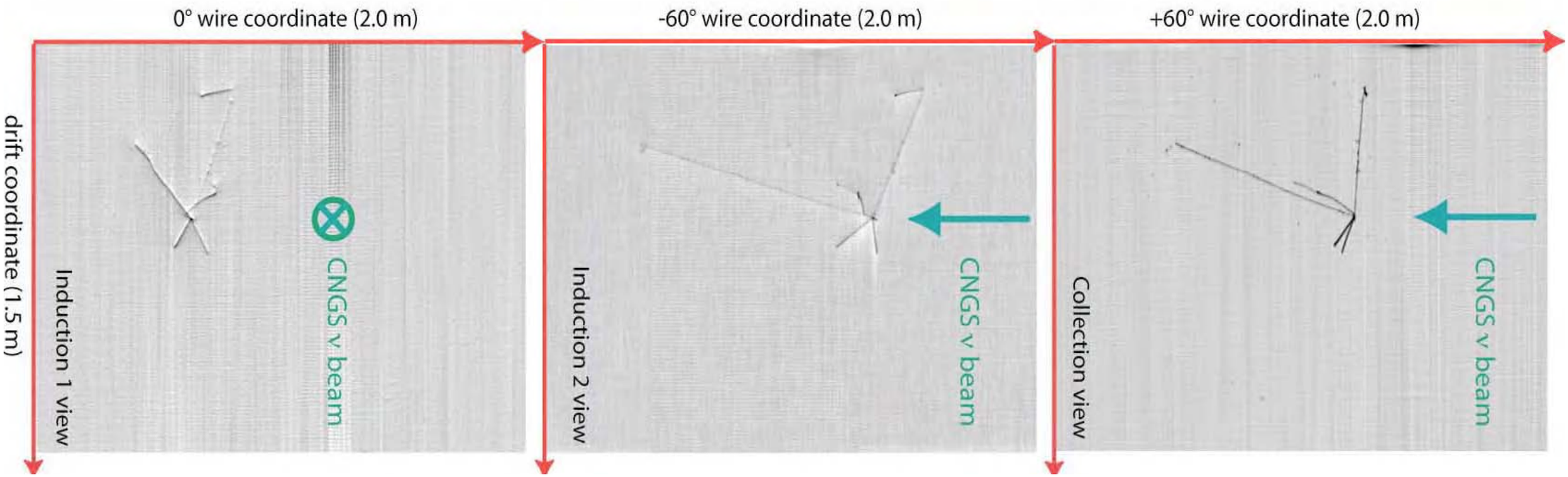


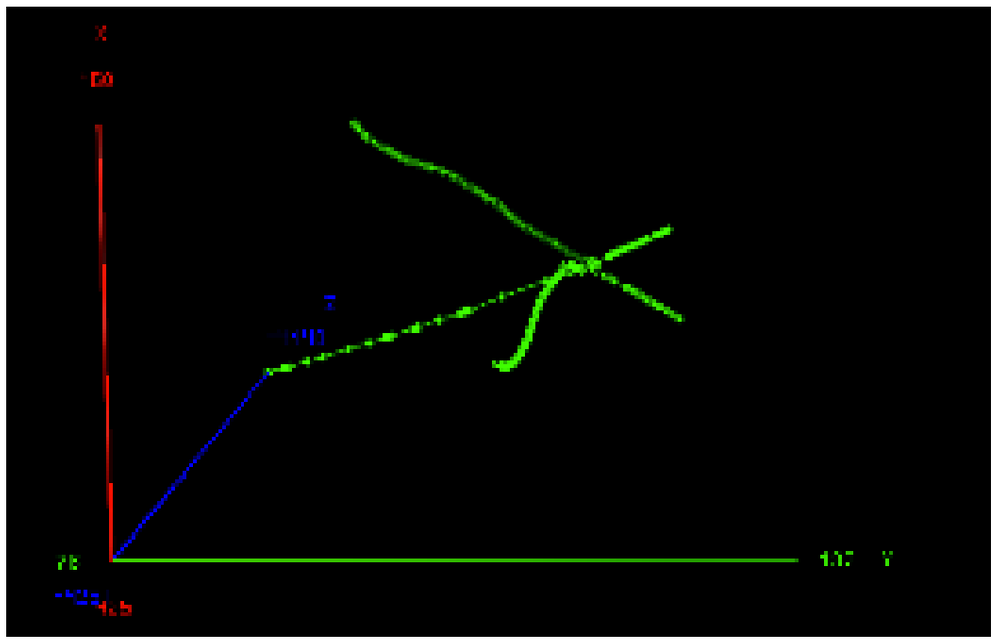


Tracking

- Current tracking (Track3dreco/SpacePts) matches clusters from 2 views by comparing their upstream/downstream endpoint time coordinates and also checks that the endpoints are from compatible wires.
- If a match is found, it creates SpacePoints by associating Hits from the 2 clusters that are the same % away from a common endpoint.
  - Straight-line trajectory is assumed in this algorithm.
  - Only create as many SpacePoints (which, in these algorithms, only have 1 Hit from each cluster) as there are Hits in the shorter cluster. The greater the disparity in the number of Hits between the matched Clusters, the more information gets lost.
  - Kalman tracking relies on these algorithms to create the set of XYZ points it uses as input .
- Thoughts:
  - Hit characteristics (i.e. - amplitude/area) are not utilized at all.
  - If we have 3 planes, should Clusters/Hits from each be used simultaneously? I doubt it.
  - Can allow arbitrary trajectories if we allow >=1 Hit from one Cluster to be associated to Hit from matched Cluster. Been thinking about this for a few months...nothing to show yet.

ICARUS Tracking





Possible Topics for Discussion Today

Some suggestions from Carl B.

- Consistent definition of hit amplitude, width and area to give the same mean value for track ionization of beam muons. Best choice for other tracks to be determined.

- Using 1st pass (tight cut) tracks and their 2D vertex to resolve additional (loose cut) 2D tracks (proton stubs & early shower development) or to filter out spurious tracks.

- Optimize matching of 2D clusters between views, perhaps using ionization fluctuations and/or total charge. Matched 2D clusters = 3D track.

- Optimizing use of hit information on 2D clusters to find dE/dx vs. x. Likely this will require merging of hits for tracks with extended time of arrival for the ionization on a wire: dipping (y-z direction cosine ~0) or wire-aligned (x-z direction cosine = +/- 0.5) tracks.

- Refitting (splitting/merging) of track hits and ionization near a vertex, based on 2D vertex and previously determined tracks.

- Hit errors, inclusion of a correlated error matrix for 2D-tracks, and propagating errors yielding 2D vertex and errors. Use of Kalman filter in 2D to incorporate multiple scattering into determination of correlated error matrix for 2D track parameters at the vertex.

Conclusions

- I think we've barely scratched the surface on understanding ultimate reconstruction capabilities in LArTPCs.
- Not sure if this meeting is a place to assign tasks, or if it's better to just use this as a dedicated forum to discuss issues and let interested people report as they wish.
- I would suggest a follow-up meeting in mid-September since several people couldn't attend today. Also allows enough time to actually do follow-up work based on our discussion today.